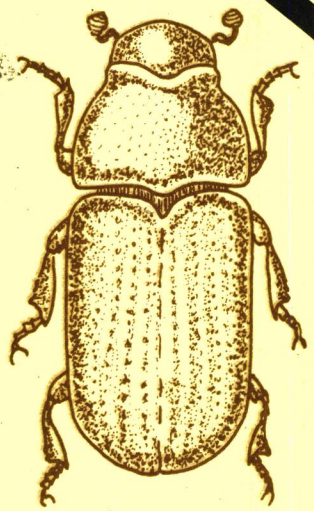
SB761
U757
77-22

R-3 77-22

BIOLOGICAL EVALUATION
Salt Damage

New Mexico State Highway 4
Adjacent to Bandelier
National Monument

1977



Southwestern Region

U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

LIBRARY

AUG 30 1977

ROCKY MOUNTAIN STATION

5230

R-3 77-22

BIOLOGICAL EVALUATION
Salt Damage

New Mexico State Highway 4
Adjacent to Bandelier National Monument

1977

Forest Insect and Disease Management
State and Private Forestry
Southwestern Region, Forest Service, USDA
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

Prepared by:

James W. Walters

JAMES W. WALTERS, Plant Pathologist
Forest Insect and Disease Management

APPROVED BY:

Donald P. Graham

DONALD P. GRAHAM, Director
Forest Insect and Disease Management

Thomas G. Schmeckpeper

THOMAS G. SCHMECKPEPER
Deputy Regional Forester
State and Private Forestry

INTRODUCTION

Chloride toxicity to roadside trees, resulting from treatment of highways with deicing salt, has occurred in many areas of the West (Piatt and Krause 1974; Scharpf and Srago 1974; Spotts et al. 1972; Walters 1974). In New Mexico, salt damage was associated with decline and mortality of white fir, corkbark fir, and Engelmann spruce trees in the Sandia Mountains (Walters 1974). Symptoms of salt damage in New Mexico are most common along highways to winter recreation areas.

Tolerance of conifers to chloride toxicity varies with the tree species (Davidson 1974). Factors affecting the amount of chloride taken up by roadside trees include proximity of the tree to the road, slope of the road shoulder, quantity of deicing salt applied, and amount of runoff from the road. Symptoms of salt damage are needle tip browning, premature needle cast, growth reduction, and gradual decline of the tree. Tree mortality commonly is associated with heavily-salted highways.

This evaluation was initiated to confirm salt damage as the cause of roadside tree decline and mortality along New Mexico Highway 4, west of Los Alamos, New Mexico. The most concentrated tree mortality along New Mexico Highway 4 occurs where it borders Bandelier National Monument. In addition to confirming chloride toxicity as the cause of tree mortality, information on levels of foliar chloride associated with damage symptoms was obtained.

Examination of roadside trees revealed scattered individuals and groups of declining and dead trees. Salt damage symptoms were present on trees from the junction of Highway 4 and Jemez Road, west for about 5 miles. All symptomatic trees were located on the downhill side of the highway. Affected trees were ponderosa pine, Douglas-fir, and white fir.

METHODS

A road log was made from the junction of Highway 4 and Jemez Road to each of 11 groups of declining trees. Groups were selected by examination of tree species and presence of salt damage symptoms. The purpose was to sample all intensities of salt damage on all three affected tree species. One tree of each species located more than 25 yards uphill from the road was sampled as a control. Two sets of control trees were taken at separate locations along the highway (total of 6 control trees).

Sample trees were tagged with aluminum tags for identification. Tags were placed on the side of the tree facing away from the road. Foliage was collected from all aspects of each sample tree. Most foliage was collected from the lower half of the tree. Chlorotic or necrotic needles were collected in preference to non-symptomatic needles on partially damaged trees. About 1 pound of needles was collected from each sample tree. Data collected for each sample tree included: tree species, diameter at breast height, damage rating, and distance from pavement edge. Distance was recorded to the nearest foot and d.b.h. to the nearest tenth inch. Damage rating (D.R.) was based on the following system:

0 = no symptoms

1 = damage to 1/3 or less of foliage, with only needle tips showing burn

2 = 1/3 to 2/3 of the foliage damaged and $\frac{1}{2}$ or less of the needle burned

3 = 2/3 or more of foliage damaged and over $\frac{1}{2}$ of the needle burned; includes brown, apparently dead trees

Foliage samples were submitted for chloride analysis to Controls for Environmental Pollution, Inc., Santa Fe, New Mexico. The procedure used in determining chloride content of the foliage was:

> The entire sample was dried at 105° C for 8 hours, weighed and placed in a large beaker. The needles were crushed and leached in deionized water for 1 hour. The water was then filtered through glass wool, the needles rinsed several times with deionized water, and all extracts were combined and measured for volume. The chloride content of the leach water was determined with chloride-specific-ion electrode and meter which were calibrated with sodium chloride standard solutions. The percentage of chloride in the dried needles was calculated knowing the chloride concentration in the leach water and the volume of liquid.

RESULTS AND DISCUSSION

Forty-one trees within 25 feet of the highway were sampled in 11 groups along the road. In addition, six control trees were sampled. The following tabulation gives the number of sampled trees by tree species and damage class.

Tree species	Damage rating				
	0	1	2	3	Control
Ponderosa pine	5	4	4	6	2
Douglas-fir	1	4	2	3	2
White fir	2	5	4	1	2
All species	8	13	10	10	6

At least one tree of each species, in each damage rating category, was sampled. The range and mean of foliage chloride content by damage category, tree species, and d.b.h. are provided in Table 1. For ponderosa pine trees, the mean percent foliar chloride increased as the damage rating increased. This trend was also apparent in Douglas-fir and white fir trees, with two exceptions. Douglas-fir trees in rating class 3 had a lower mean chloride content than those with D.R.'s of 1 or 2. This exception may be attributed to difficulty in assigning a D.R. to Douglas-fir trees. Symptoms of salt damage were less pronounced on Douglas-fir than on ponderosa pine or white fir trees. The second exception involved white fir trees with a D.R. of 0 and 1 having a similar mean chloride content. The cause of this disparity was not determined.

Control trees of all species had less foliar chloride than roadside trees in any D.R. category (D.R. = 0 - 3). Although roadside trees in D.R. = 0 category had no symptoms of chloride toxicity, they contained more chloride than control trees. The range and mean d.b.h. for sample trees are provided as a reference and show variability of sample tree size. These measurements also will aid in relocating tagged trees for future examinations.

A trend in foliar chloride content was evident when D.R. = 1-3 categories for all species were grouped and compared with D.R. = 0 and control trees (Table 2). Chloride content was lowest in control trees, increased in non-symptomatic (D.R. = 0) trees, and reached the highest levels in symptomatic trees (D.R. = 1-3). Mean chloride content of white fir trees was lower than that found in a similar evaluation of salt damage in the Sandia Mountains, New Mexico (Walters 1974). Chloride levels in white fir were somewhat lower than those noted in a California and Nevada study (Scharpf and Srago 1974). Comparable data were not available for ponderosa pine or Douglas-fir in New Mexico.

As distance from sample trees to the pavement edge increased, foliar chloride levels decreased in all species (Table 3). The one exception to this trend was white fir trees located 21-25 feet from the highway. Of the two trees sampled in this distance category, foliar chloride contents were .22 g/100 g and .90 g/100 g. The high chloride content of the latter tree was probably caused by some microsite factor which allowed an unusual amount of deicing salt runoff to reach the root system.

CONCLUSIONS AND RECOMMENDATIONS

Symptoms of salt damage were noted in 1976 on ponderosa pine, Douglas-fir, and white fir along New Mexico Highway 4 near Los Alamos, New Mexico. Many roadside trees were in a state of gradual decline and mortality was present in the aforementioned tree species. Foliage chloride analysis of 41 symptomatic trees indicated chloride toxicity as the major cause of tree decline. Roadside trees with no symptoms of salt damage had higher foliar chloride levels than control trees which were not exposed to deicing salt runoff. Chloride content of foliage was highest in trees growing nearest to the highway and decreased as distance from the pavement increased. Results of this evaluation indicate that trees located as far as 25 feet from the highway can take up chloride from deicing salt runoff. No maximum distance for deicing salt runoff and uptake of chloride by roadside trees was established in this study.

Sample trees will be reexamined annually to determine the rate of mortality for affected trees. Decline and death of roadside trees can be expected to continue in future years. The mortality rate may vary, depending on the rate of deicing salt application and quantity of highway runoff. Most roadside tree decline and mortality should occur within 25 feet of the pavement. The New Mexico State Highway Department will be contacted in regard to potential for reducing the rate of deicing salt application on Highway 4 near Los Alamos, New Mexico.

LITERATURE CITED

Davidson, H. 1974. Trees reflect different tolerance levels to deicing salts. Voice of Man, Michigan State Nursery Notes, March-April 12.

Piatt, J. R., and P. D. Krause. 1974. Road and site characteristics that influence road salt distribution and damage to roadside aspen trees. Water, Air, and Soil Pollut. 3: 301-304.

Scharpf, R. F., and M. Srago. 1974. Conifer damage and death associated with the use of highway deicing salt in the Lake Tahoe Basin of California and Nevada. USDA Forest Serv. Calif. Reg. Forest Pest Contr. Tech. Rep. 1. 16 pp.

Spotts, R. A., J. Altman, and J. M. Staley. 1972. Soil salinity related to ponderosa pine tipburn. Phytopathol. 62(7): 705-708.

Walters, J. W. 1974. Evaluation, salt damage. USDA Forest Serv. Southwestern Reg. Biol. Evaluation R-3 75-4. 9 pp.

Table 1.--Range and mean for percent chloride and d.b.h. by tree species and damage rating category.

Species	Damage rating	No. trees	% Cl		D.b.h. (inches)	
			Range	Mean	Range	Mean
Ponderosa pine	0	5	.10-.42	.19	1.6-5.6	3.6
	1	4	.25-.80	.51	1.5-11.4	6.7
	2	4	.33-.99	.59	2.6-9.0	4.9
	3	6	.19-1.14	.64	1.2-13.6	4.4
	Control	2	.09	.09	1.8-6.2	4.0
Douglas-fir	0	1	.11	.11	7.8	7.8
	1	4	.07-.67	.29	4.1-6.0	5.0
	2	2	.43-1.14	.79	4.0-4.9	4.5
	3	3	.16-.35	.28	3.1-12.9	6.4
	Control	2	.03-.04	.04	3.5-6.9	5.2
White fir	0	2	.22-.25	.24	3.6-7.2	5.4
	1	5	.13-.38	.20	3.4-13.1	6.7
	2	4	.20-.90	.44	2.2-10.7	5.7
	3	1	.79	.79	6.4	6.4
	Control	2	.05	.05	4.1-6.4	5.3

Table 2.--Mean percent chloride by damage rating category and tree species.

Tree species	D.R. = 1-3		D.R. = 0		Controls	
	No. trees	$\bar{X}$ % Cl	No. trees	$\bar{X}$ % Cl	No. trees	$\bar{X}$ % Cl
Ponderosa pine	14	.59	5	.19	2	.09
Douglas-fir	9	.40	1	.11	2	.04
White fir	10	.36	2	.24	2	.05
All species	33	.47	8	.19	6	.06

Table 3.--Mean percent chloride for all damage rated trees (D.R. = 0-3) by distance from pavement and tree species.

Distance (feet)	Ponderosa pine		Douglas-fir		White fir		All species	
	No. trees	$\bar{X}$ % Cl	No. trees	$\bar{X}$ % Cl	No. trees	$\bar{X}$ % Cl	No. trees	$\bar{X}$ % Cl
6-10	2	.655	0	--	2	.615	4	.635
11-15	10	.574	8	.393	6	.237	24	.429
16-20	6	.340	1	.350	2	.130	9	.294
21-25	1	.100	1	.180	2	.560	4	.350